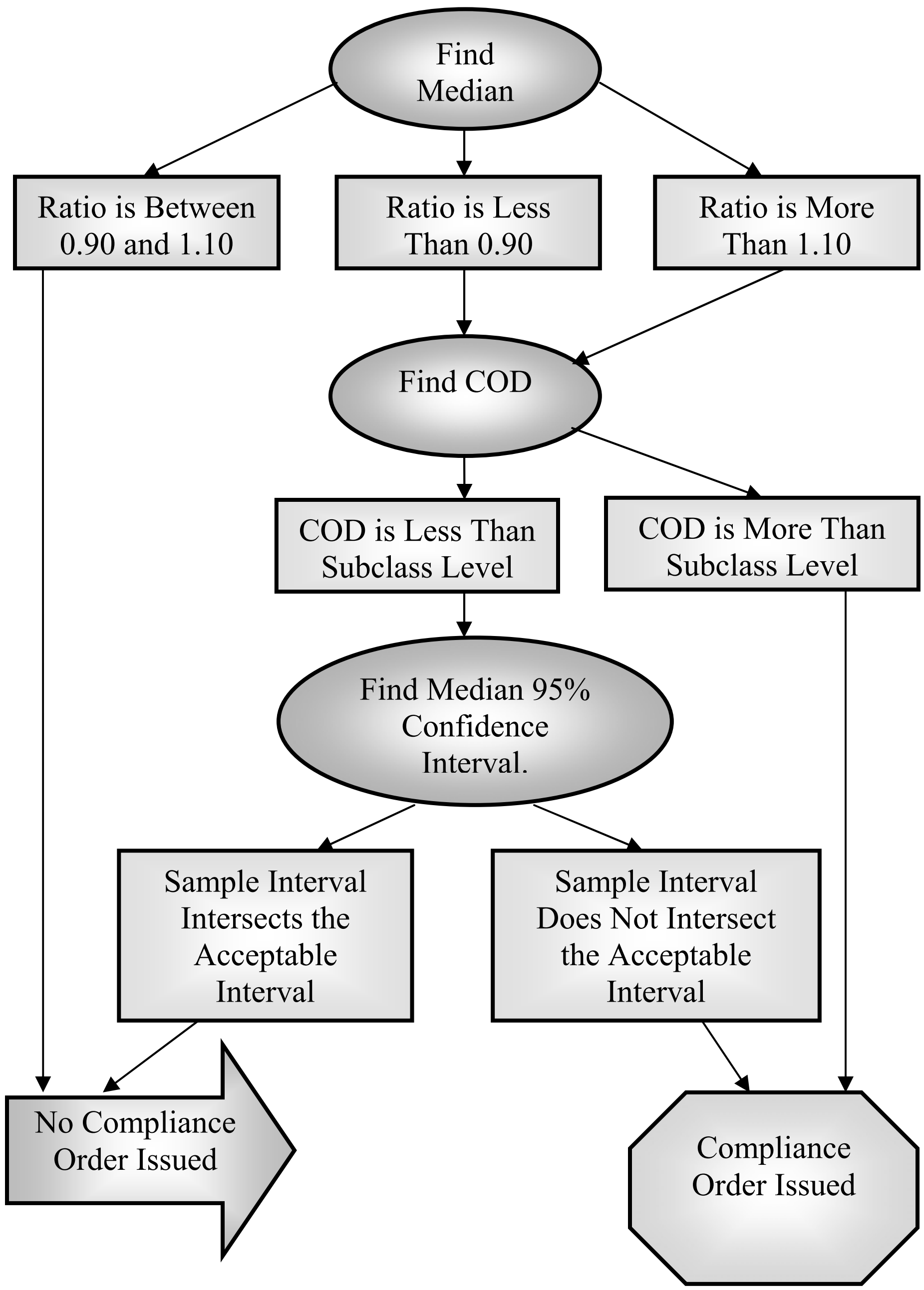
Ratio Study
Decision Model

State Tax Commission of Missouri



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I. Introduction to the Ratio Study Decision Model

The State Tax Commission, as outlined in the Missouri Constitution, has three primary functions:

1) to ensure equalization of assessments between counties;
2) to hear appeals from local boards of equalization in individual assessment cases; and
3) to perform such other duties as may be prescribed by law.

Within the constitutional framework, the State Tax Commission envisions an ad valorem assessment landscape which ensures the equitable treatment of all property and values an assessment system which attains uniformity in the assessment of property within a class.

The Ratio Study conducted by the Commission is utilized to determine whether assessments are fair and uniform. The Ratio Study Decision Model is a process that provides for the uniform analysis of the Ratio Study statistics and allows the Commission to conclude whether assessments comply, or not, with statutory requirements.

II. Basic Statistics

Statistics is the branch of applied mathematics that concerns itself with the collection of quantitative data, testing inferential hypotheses, and estimating population parameters using probability theory. The State Tax Commission of Missouri upholds an ad valorem tax assessment by applying statistics and the tools thereof to fairly and accurately uphold the constitution and statutes of the State. The Decision Model within the Ratio Study, which promotes equalization of values and estimation of total market worth, exemplifies an analysis specifically adhering to the principles of statistics.

II.A. Introduction

The statistics used by the State Tax Commission of Missouri begins with a defined population. A **population** is the set of all entities the study finds of interest. All vacant and improved parcels residing in the residential subclass comprises the residential population for that county. A **simple random sample** is a representative subset of the population. A study is said to be **random** if each individual from the population has an equal chance of entering the set of sample selections. Samples are **independent** if the value or results of one individual does not affect another. For the Commission's assessment ratio study, approximately thirty-five assessments from each subclass of real property are randomly selected to create a representative, independent sample.

Data, the collection of factual information, is drawn from the study of each individual from the sample. Both qualitative and quantitative values are used to form inferences that justify hypotheses. An **inference** is the deductive and inductive logical reasoning involved in forming a conclusion or premise. A **statistic** is the arithmetic metric that is derived from an inference to describe a sample. Statistics are often considered to be estimates that describe the population's true distribution and attributes. Examples of statistics include the sample mean, $\bar{x}$, and the sample variance, s^2. A **parameter** is an estimate of the population metrics. Such examples of a parameter would be the population mean, μ, and the population variance, σ^2. A **census** occurs when the entire population is included in the sample. It should also be known that statistics used to describe a sample are denoted with English letters whereas parameters are symbolized with the Greek alphabet.

II.B. Descriptive Statistics

Descriptive statistics summarize the distribution of the collected data. Knowing such information permits statisticians the ability to analyze and interpret characteristics that will be important for the study. The following describes the important descriptive statistics that are imperative for analysts of all levels to be aware. The descriptive statistics will be defined and discussed through examples using the data from **Table 1**.

Sample	Assessed Value	Appraised Value	Ratio
1	$5,780	$42,200	0.1370
2	$100	$500	0.2000
3	$5,720	$31,800	0.1799
4	$3,230	$17,400	0.1856
5	$11,540	$59,100	0.1953
6	$1,330	$16,200	0.0821
7	$4,580	$25,900	0.1768
8	$3,290	$20,800	0.1582
9	$3,840	$22,300	0.1722
10	$5,350	$35,700	0.1499
11	$160	$700	0.2286

Table 1

II.B.1. Measurements of Central Tendency
II.B.1.a. Mean

The **mean**, also known as the arithmetic average, is created by adding together all individual samples and dividing by the number of samples. The sample mean $\bar{x}$ is computed as follows:

Let n represent the number of observations in the sample.
Let x_i represent the i^{th} observation of the sample.

$$\bar{x} = \frac{x_1 + x_2 + \ldots + x_{n-1} + x_n}{n} = \frac{\sum_{i=1}^{n} x_i}{n}$$

II.B.1.b. Mean Ratio

The mean ratio is a helpful statistic. Some advantages of using the mean ratio include the ease in understanding the concept, the value of every ratio is considered, and further statistical applications can be used that are based around the value of the mean.

For the mean ratio from the data provided in Table 1, one would add all of the ratio values together and divide by the number of samples. In this scenario,

$$\bar{x} = \frac{0.1370 + 0.2000 + ... + 0.1499 + 0.2286}{11} = \frac{1.8655}{11} = 0.1696$$

II.B.1.c. Median

The **median,** $\tilde{x}$, is the middle observation when the values of the data are arrayed (listed from smallest to largest or largest to smallest).

If the number of observations is odd,	If the number of observations is even,
$\tilde{x} = \left(\frac{n+1}{2}\right)^{th}$ ordered value.	$\tilde{x} = \frac{\left(\frac{n}{2}\right)^{th} + \left(\frac{n+1}{2}\right)^{th}}{2}$ ordered values.

That is, if the number of observations is odd, the middle observation of the arrayed data is the median. When the number of observations is even, the average of the two middle-most ordered observations is the median.

II.B.1.d. Median Ratio

The median ratio is an ordered statistic that concerns itself only with the middlemost value(s). It is determined by listing the ratios in order and finding the one in the middle. **Table 2** below shows the ratios listed in an ascending order.

Sample	Assessed Value	Appraised Value	Ratio	Rank
6	$1,330	$16,200	0.0821	1
1	$5,780	$42,200	0.1370	2
10	$5,350	$35,700	0.1499	3
8	$3,290	$20,800	0.1582	4
9	$3,840	$22,300	0.1722	5
7	$4,580	$25,900	0.1768	6
3	$5,720	$31,800	0.1799	7
4	$3,230	$17,400	0.1856	8
5	$11,540	$59,100	0.1953	9
2	$100	$500	0.2000	10
11	$160	$700	0.2286	11

Table 2

Since there are 11 samples, n=11.

$$\tilde{x} = \left(\frac{n+1}{2}\right)^{th} = \left(\frac{11+1}{2}\right)^{th} = \left(\frac{12}{2}\right)^{th} = 6^{th} = 0.1768$$

II.B.1.e. Mode

The **mode** of a numerical data set is the value or values that occur most frequently. A sample can have more than one mode.

Unimodal – One mode
Bimodal – Two modes
Multimodal – Two or more modes

II.B.1.f. Weighted Mean

The **weighted mean** is another descriptive statistic that describes central tendency. Weighted means generally are used in physics to describe moments of inertia and the center of mass. However, the weighted mean can also be applied to population studies in statistics. It is calculated by summing both the individual assessed values and the individual indicators of market value, sale prices or appraised values.

That is, for the weighted mean, $\hat{x} = \dfrac{\sum Assessed}{\sum Appraised}$.

II.B.1.g. Weighted Mean Ratio

The weighted mean ratio reflects the relationship of the total assessed value to the total market value of each subclass. From **Table 1**, the weighted mean ratio would be discovered using the following formula:

$$\hat{x} = \frac{\sum Assessed}{\sum Appraised} = \frac{\$44{,}920}{\$272{,}600} = 0.1648$$

II.B.1.h. Price Related Differential

The Price Related Differential (PRD) is found by dividing the mean by the weighted mean. The statistic has a slight bias upward. Price related differentials above 1.03 tend to indicate assessment regressivity (an appraisal bias such that high-value properties are appraised lower than low-valued properties); PRD’s less than 0.98 tend to indicate assessment progressivity (an appraisal bias such that high-valued properties are appraised higher than low-valued properties).

II.B.2. Measurements of Variation

II.B.2.a. Quartiles

Quartiles, like medians, are ordered statistics based on the n^{th} observation. The median divides the data set into two distinct subsets: a lower subset and an upper subset. The lower subset consists of all data ranging from the minimum value to the median and the upper subset consists of all data ranging from the median to the maximum value. The **first quartile** is the median of the lower subset and the **third quartile** is the median of the upper subset. That is, when the data is ranked in ascending order, the data ranked at the 25th percentile is the first quartile and the data ranked at the 75th percentile is the third quartile. (The median can sometimes be considered as the second quartile.)

First Quartile	$\tilde{x}_1 = \left(\frac{n+1}{4}\right)^{th}$ ordered value.
Third Quartile	$\tilde{x}_3 = \left(\frac{3n+3}{4}\right)^{th}$ ordered value.

II.B.2.b. Interquartile Range

The interquartile range (IQR) is a metric that will help detect **outliers**. An outlier is an unusual observation that lies well below or well above what was expected. The interquartile range is calculated by subtracting the first quartile from the third quartile, taking the absolute value, and multiplying that by 1.5. Take this quantity and subtract it from the first quartile. That is the minimum value for the IQR. The maximum value for the IQR is obtained by adding the same metric to the third quartile.

IQR = $\left(Q_1 - \left|Q_3 - Q_1\right| * 1.5\ ,\ Q_3 + \left|Q_3 - Q_1\right| * 1.5\right)$

Extrema are outliers that are considered to be implausible and have a heavy influence on many descriptive statistics such as the mean. Extrema ranges are calculated using 3.0 instead of 1.5 from the formula listed above.

EQR = $\left(Q_1 - \left|Q_3 - Q_1\right| * 3\ ,\ Q_3 + \left|Q_3 - Q_1\right| * 3\right)$

II.B.2.c. Quartile and Interquartile Example

From the data in Table 2 in which the ratios are ranked, the first quartile would be the 3rd observation, 0.1499 and the third quartile would be the 9th observation, 0.1953. The interquartile range would be found as follows:

IQR = $\left(0.1499 - \left|0.1953 - 0.1499\right| * 1.5\ ,\ 0.1953 + \left|0.1953 - 0.1499\right| * 1.5\right)$
IQR = $\left(0.1499 - \left|0.0454\right| * 1.5\ ,\ 0.1953 + \left|0.0454\right| * 1.5\right)$
IQR = $\left(0.1499 - 0.0454 * 1.5\ ,\ 0.1953 + 0.0454 * 1.5\right)$
IQR = $\left(0.1499 - 0.0454 * 1.5\ ,\ 0.1953 + 0.0454 * 1.5\right)$
IQR = $\left(0.1499 - 0.0681\ ,\ 0.1953 + 0.0681\right)$

IQR = $(0.0818\ ,\ 0.2634)$

II.B.2.d. Standard Deviation

The standard deviation measures a sample's level of variability and spread. Calculating the standard deviation of a distribution without the aid of a computer spreadsheet application can easily become a difficult task. (Please note: to calculate a sample's variance, another measurement of variability in a sample, please stop after step 4 in the table below.)

Step	The standard deviation of a sample is	$s = \sqrt{\frac{\sum_{i=1}^{n}(x_i - \bar{x})^2}{n-1}}$
1	First, subtract the mean from each individual, x_i	$x_i - \bar{x}$
2	Square each of these differences.	$(x_i - \bar{x})^2$
3	Add each of these differences together.	$\sum_{i=1}^{n}(x_i - \bar{x})^2$
4	Divide the sum of the squared differences by the number of observations minus 1.	$\frac{\sum_{i=1}^{n}(x_i - \bar{x})^2}{n-1}$
5	Take the square root of this value.	$s = \sqrt{\frac{\sum_{i=1}^{n}(x_i - \bar{x})^2}{n-1}}$

II.B.2.e. Standard Deviation about the Mean

Ratio	0.0821	0.1370	0.1499	0.1582	0.1722	0.1768	0.1799	0.1856	0.1953	0.2000	0.2286
Step 1	-0.0875	-0.0326	-0.0197	-0.0114	0.0026	0.0072	0.0103	0.0160	0.0257	0.0304	0.0590
Step 2	0.0077	0.0011	0.0004	0.0001	0.0000	0.0001	0.0001	0.0003	0.0007	0.0009	0.0035
Step 3	0.0147										
Step 4	0.0015										
Step 5	**0.0384**										

II.B.2.f. Coefficient of Variation

One giant drawback to the standard deviation metric is that it should not be compared to standard deviations from other samples. Acceptance of basic inferences cannot be made strictly from the comparison of the standard deviations. For example, a distribution with a large standard deviation with a sample mean $\bar{x}$ centered near the population mean μ may be more accurate than a distribution with a smaller standard deviation. The coefficient of variation is a single metric that permits comparison of distributions while accounting for samples' standard deviations and means. A small coefficient of variation is preferred. However, the coefficient of variation is not a good test statistic, and anyone who uses this metric for comparison purposes between data samples should do so with extreme caution.

The formula for the coefficient of variation is the quotient of the standard deviation and the mean, multiplied by one hundred. (Please note: The Coefficient of Variation is different from the covariance, which is also often denoted by the abbreviation CoV.)

$$CoV = \left(\sqrt{\frac{\sum_{i=1}^{n} (x_i - \bar{x})^2}{n-1}} \right) \times \frac{100}{\bar{x}}$$

II.B.2.g. Coefficient of Variation Example

$$CoV = \left(\sqrt{\frac{\sum_{i=1}^{n} (x_i - \bar{x})^2}{n-1}} \right) \times \frac{100}{\bar{x}} = 0.0384 \times \frac{100}{0.1696} = 22.6415$$

II.B.2.h. Standard Error of Mean Ratio

The standard error in a mean ratio measures the extent to which each individual ratio in a sample differs from that of the predicted value. The standard error of the mean ratio can be estimated using a predicted value of the population's standard deviation through the standard deviation of the sample.

$$\text{Standard Error of Mean Ratio} = \frac{s}{\sqrt{n}}$$

II.B.2.i. Standard Error of Mean Ratio Example

Recall s = 0.0384 (the standard deviation about the mean) as observed in section II.B.2e.
Recall n = 11 as observed in Table 1.

$$\text{Standard Error of Mean Ratio} = \frac{s}{\sqrt{n}} = \frac{0.0384}{\sqrt{11}} = \frac{0.0384}{3.31662} = 0.0116$$

II.B.2.j. Confidence Interval

A **confidence interval** is a range in which the true mean of the population, μ, is expected to lie based on a predetermined percent of accuracy. For example, a 95% confidence interval gives a range of values. These values predict that the true mean of the population from which the sample was taken lies within the interval. As the confidence level decreases from 95%, the range becomes smaller. Similarly, if the confidence level increases from 95%, the range becomes larger.

II.B.2.k. Coefficient of Dispersion

The Coefficient of Dispersion (COD) is a measurement of variability. A lower Coefficient of Dispersion implies a less amount of variability. The COD measures the average percentage deviation of the ratios from the median ratio and is calculated from the following steps:

1. Calculate the deviation by subtracting the median from each ratio.
2. Find the absolute value of the deviations.
3. Sum the absolute deviations.
4. Divide by the number of ratios to obtain the "average absolute deviation."
5. Divide by the median.
6. Multiply by 100.

II.B.2.l. COD Example

From the data in Table 1, the coefficient of dispersion has been calculated, where the median is 1.0768:

Ratio	0.0821	0.1370	0.1499	0.1582	0.1722	0.1768	0.1799	0.1856	0.1953	0.2000	0.2286
Step 1	-0.0947	-0.0398	-0.0269	-0.0186	-0.0046	0.0000	0.0031	0.0088	0.0185	0.0232	0.0518
Step 2	0.0947	0.0398	0.0269	0.0186	0.0046	0.0000	0.0031	0.0088	0.0185	0.0232	0.0518
Step 3	0.2900										
Step 4	0.0264										
Step 5	0.1491										
Step 6	**14.9116%**										

II.B.2.m. 95% Median Confidence Interval

Unlike the confidence interval about the mean, the median confidence interval is not based on the assumption of a normal distribution. It is found by ranking the data: sorting the data in increasing order and assigning each data point a number based on the value in relation to the others. If two or more data points are tied for the same rank, the rank assigned to these values is averaged.

To determine the upper and lower limits of the confidence interval, first calculate the position of the limits. If the number of samples in the array is even, use:

$$j = \frac{1.96 \times \sqrt{n}}{2}$$

If the number of observations is odd,

$$j = \frac{1.96 \times \sqrt{n}}{2} + 0.5$$

After determining the value of j, round the value up to the highest integer. From the values that are ranked, find the median, and count up and down j data points to find the limits of the confidence interval.

Using the data from Table 1, the limit, j, would be calculated to be:

j = ((1.96 x SqRt(11))/2) + 0.5
j = 3.75
j = 4

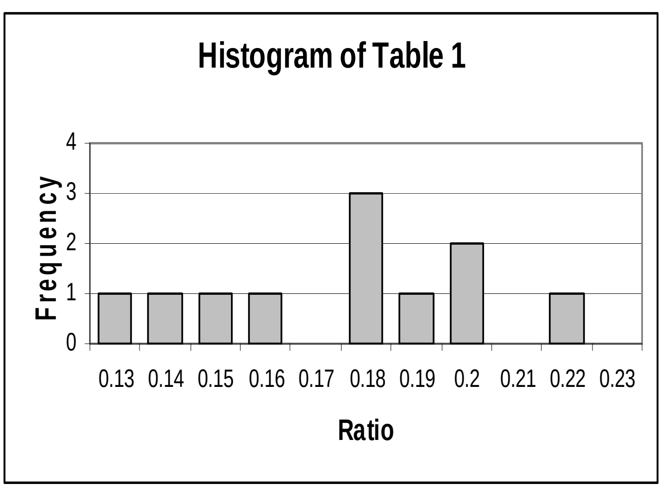
And the lower and upper limits would be found, 4 positions, above and below the median. That is, the confidence interval would be from 0.1370 to 0.2000.

III. Graphing Techniques

There are a variety of graphs that describe the trends of data in visual ways. Some of the basic graph types include the histogram, boxplot, and scatterplot.

III.A. Histogram

A histogram is a graph that is often referred to as the "bar graph." The histogram is best when used with discrete or categorical data. Continuous data must first be placed into bin ranges with counts before it can be plotted on a graph. The advantages of a histogram include the ease of interpretation and visualization of the data when compared to counts.



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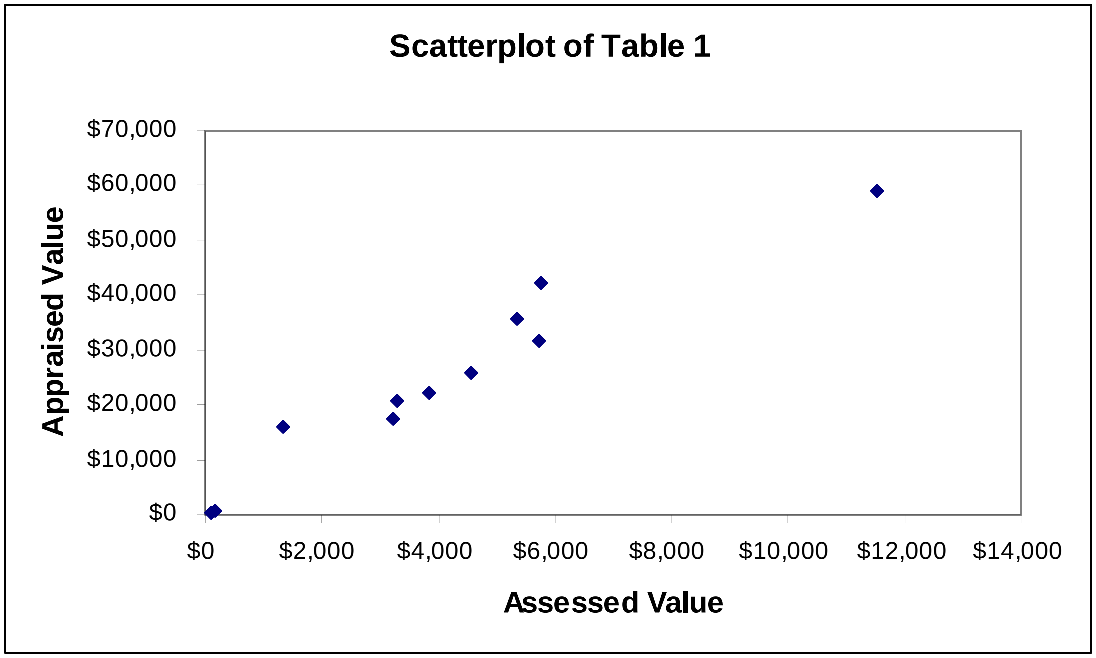
9	$3,840	$22,300	0.1722
10	$5,350	$35,700	0.1499
11	$160	$700	0.2286

Table 1

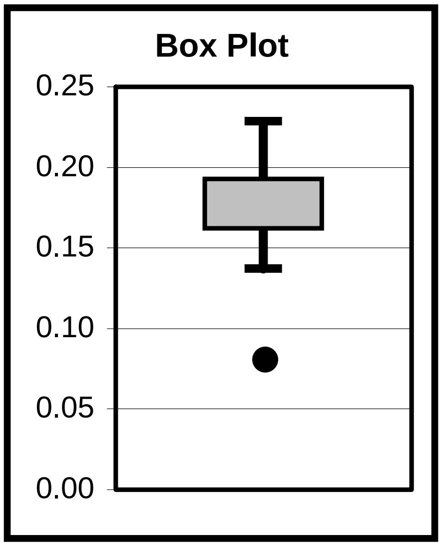
III.B. Scatterplot

A scatterplot is a graph that compares two sets of continuous data. It is advantageous as it compares the cluster and spread of the data for the two sampled sets. Trends can be seen that show the relationship between these groups. It can be disadvantageous, however, as categorical variables with discrete data cannot be displayed.



III.C. Boxplot

A boxplot is a graph that displays the trends of a continuous sample and concerns the minimum, the first quartile, the median, the third quartile, and the maximum. Outliers are identified visually and a sense of the distribution of the data is gained from the graph. The first and third quartiles form a box with one quartile on each end. The median is represented with a line that splits the box. The smallest point that lies within the interquartile range is denoted with a small tick. A line is then connected from this small dash to the box. The same illustrations are done for the largest point within the interquartile range. The outliers, the data points that lie above or below the interquartile range, are denoted with small dots.



IV. Compliance Order Decision Model

The State Tax Commission issues a compliance order when a statistical study indicates that assessments in the subject jurisdiction are not within an acceptable range of the assessment level required by statute. The following steps in the decision model depict the process used in determining whether or not to issue a compliance order.

IV.A. Find the Median Ratio

The first statistic observed, to ensure the quality of assessment in a county, is the median ratio. The median ratio is the middlemost ratio value when the ratios are listed in ascending order. The State Tax Commission of Missouri has adopted the International Association for Assessing Officers (IAAO) standard for ratio studies, that is, the median ratio should be plus or minus 10% of the statutory level. Thus, any median ratios outside of this range will trigger a red flag suggesting that a compliance order could be issued.

IV.B. Find the Coefficient of Dispersion

When the median ratio exceeds the 10% tolerance level, the Coefficient of Dispersion (COD) is examined. The Coefficient of Dispersion is a measurement of variability, it assesses the horizontal uniformity of property. A lower Coefficient of Dispersion implies a less amount of variability. The table below displays the maximum values for the coefficient of dispersion:

Subclass	Max COD
Residential	25%
Agricultural	30%
Commercial	30%

IV.C. Find the Sample's 95% Confidence Interval about the Median

If the COD is less than or equal to the maximum COD level listed in the table above and the median ratio exceeds the plus/minus 10% tolerance level, the 95% Confidence Interval about the Median is considered. If the confidence interval fails to intersect the plus or minus 10% range, then a compliance order will be issued.

Subclass	Lower Boundary	Upper Boundary
Residential	17.1%	20.9%
Agricultural	10.8%	13.2%
Commercial	28.8%	35.2%

IV.D. Compliance Order Example

Suppose that a county has produced the set of data for the residential subclass listed on Table A of the appendix.

The first step would be to list the ratios in ascending (increasing) order and rank them. This has been done in Table B of the appendix.

Now, find the median value, which in this scenario, is 17.0, the middlemost value.

To determine if the median ratio falls within the plus/minus 10% range, divide 17.0 by 19.0, the rate at which the residential property is assessed.

$$\frac{17.0}{19.0} = 0.89$$

Since 0.89 fails to fall within the range of 0.90 and 1.10, the test for the Coefficient of Dispersion is applied. The directions for computing the Coefficient of Dispersion are listed below: Table C in the appendix shows the arithmetic behind the steps for finding the COD.

1. Calculate the deviation by subtracting the median from each ratio.
2. Find the absolute value of the deviations.
3. Sum the absolute deviations.
4. Divide by the number of ratios to obtain the "average absolute deviation."
5. Divide by the median.
6. Multiply by 100.

In this example, the Coefficient of Dispersion is 24.781%, which is less than 25%. Note, this statistic was largely affected by the outlier 60.00. This sampled data barely passes the Coefficient of Dispersion test. Now, the test for the 95% confidence interval is applied.

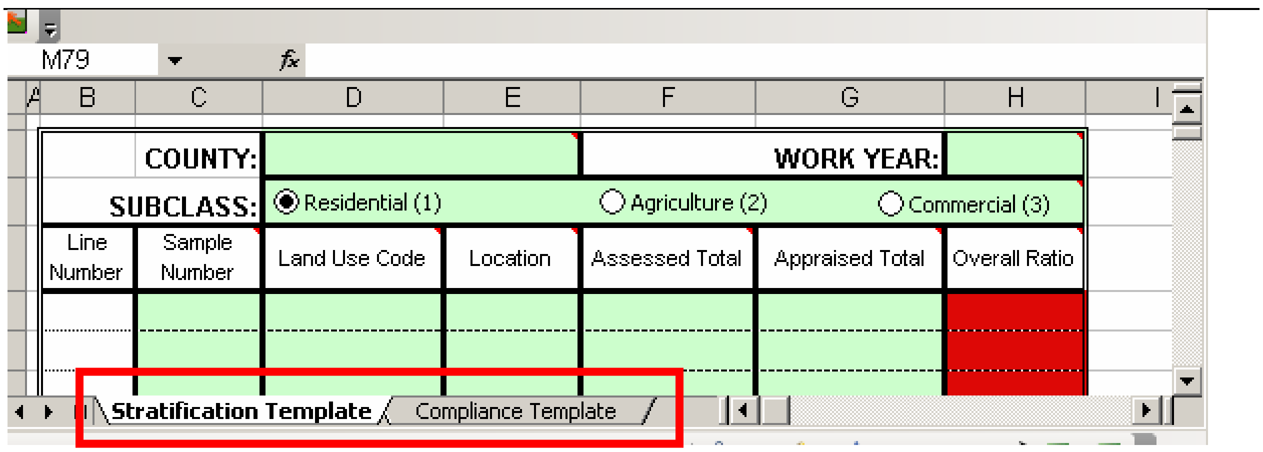
Using confidence intervals about the median, the 95% confidence interval for the sample is 16.65% - 17.70%. Since the 95% confidence interval intersects the State Tax Commission's adopted interval, (17.1% - 20.9%), the sample has avoided the compliance order.

V. County Ratio Template

A template has been placed on the State Tax Commission of Missouri's website to help counties find their own ratio statistics.

V.A. Getting Started

To run CountyRatioTemplate.xls, the user must have a computer that runs Excel 2003. The file is compatible with Windows, Macintosh, and Linux based processors. After downloading the file from the website, launch the file to open up Excel. There are two worksheets: Stratification Template and Compliance Template. The Stratification Template is the area for entering the data for the county. Important descriptive statistics will then be generated. The Compliance Template uses these statistics to complete a concept map that describes how and why a compliance order may be issued. To select between the worksheets, notice the two tabs at the bottom-left of the Excel file. Click on the desired tab.



V.A.I. Reading Cell Addresses

A cell's address is described by the intersection of the column letter and row number. For example, cell C5 refers to the first cell in the list for the sample number and it is found in the third column (column C) on the fifth row (row 5).

V.A.II. Reading File Comments

The Excel worksheet has had several comments added to the file. A comment will automatically appear in the form of a yellow sticky note when the cursor rolls over certain cells in the file. These comments are created to help answer questions the user may have. To view all comments at once, from the menu bar, choose "View" and then "Comments." To remove these comments from view, choose "View" and then "Comments" one more time.

V.B. Data Entry

The following is a list of items the user must enter to find the statistics for the county:

- County
- Work Year
- Subclass
- Sample Number
- Land Use Code
- Location
- Assessed Total Value
- Appraised Total Value

These items and areas for entry on the Excel file are denoted with a light green background. As items are entered, Excel will begin to fill out the rest of the worksheet.

V.B.1. County

Enter the name of the county in cells D2:E2.

V.B.2. Work Year

Enter the year in cell H2.

V.B.3. Subclass

Select the subclass from the radio buttons in cells D3:H3.

V.B.4. Sample Number

Enter the sample number starting in C5. Observe that as data in some of these columns is entered, other cells will automatically fill themselves in.

V.B.5. Land Use Code

Enter the land use codes in column D. Here is a quick reference for the land use codes:

Residential

1: Single Family Residential
6: Vacant Residential Land
11: Duplex/Triplex/4-Plex
12: Commercial Type Properties
13: Multi-Family consisting of 5 or more units

Agricultural

2. Farm
5. Vacant Agricultural Land

Commercial

3. Vacant Commercial Land
4. Vacant Industrial Land
7. Improved Commercial Property
8. Improved Industrial Property
9. Multi-Family – Commercial
10. Office

V.B.6. Location

Enter a number code from 1-5 that represents the demographics of the location in column E. For example, 1 could represent an urban area. The number 2 could represent a rural area.

V.C. Stratifying Data

Stratifying data is a statistical technique that examines a subset of a population. Each stratification category will provide the minimum, maximum, count, mean, median, weighted mean, COD, PRD, Standard Deviation, and COV based on the overall ratios. This Excel file will stratify data based on three defined categories:

- Land Use Code
- Location
- Appraised Value

It is possible to change the Land Use Code and Location options at the bottom of the Excel file. The checked boxes represent the coded symbols (1-13 for Land Use Codes and 1-5 for Location) that are allocated to each of the subcategories such as improved and vacant or urban and rural. The user can set these numbers, and the statistics on the page will automatically adjust.

The appraised values (rows 71-74) have been programmed into the Excel file based on nonparametric statistical stratification. These intervals for stratification have been arbitrarily chosen. Therefore, each county will probably have more distinctive intervals of interest. Thus, an additional stratification by appraised values has been coded into the Excel file. For cells E78 and F78, the user can enter the minimum and maximum values as desired.

VI. Compliance Template

After all of the data is entered in the stratification template, this worksheet will display the important statistics that are used to identify counties that should receive compliance orders. The worksheet follows the flow chart logic that is displayed on page one of this manual. This logic is explained in Section IV.

If a county has a statistic that meets statutory requirements it will be labeled with a green background. Should any red backgrounds appear, that triggers a red flag suggesting that a compliance order may be issued.

APPENDIX

Table A	
Ratio Data	
Sample	**Ratio**
1	17.30
2	16.64
3	17.50
4	16.65
5	17.70
6	17.00
7	60.00
8	16.68
9	17.29
10	16.76
11	16.72

Table B		
Ratio Data Ranked		
Sample	Ratio	**Rank**
2	16.64	1
4	16.65	2
8	16.68	3
11	16.72	4
10	16.76	5
6	17.00	6
9	17.29	7
1	17.30	8
3	17.50	9
5	17.70	10
7	60.00	11

Steps for computing the COD (Coefficient of Dispersion)

1. Calculate the deviation by subtracting the median from each ratio.
2. Find the absolute value of the deviations.
3. Sum the absolute deviations.
4. Divide by the number of ratios to obtain the "average absolute deviation."
5. Divide by the median.
6. Multiply by 100.

Table C								
Coefficient of Dispersion								
Sample	Ratio	Rank	**Step 1**	**Step 2**	**Step 3**	**Step 4**	**Step 5**	**Step 6**
2	16.64	1	-0.36	0.36	46.34	4.2127	0.2478	**24.781%**
4	16.65	2	-0.35	0.35				
8	16.68	3	-0.32	0.32				
11	16.72	4	-0.28	0.28				
10	16.76	5	-0.24	0.24				
6	17.00	6	0.00	0				
9	17.29	7	0.29	0.29				
1	17.30	8	0.30	0.3				
3	17.50	9	0.50	0.5				
5	17.70	10	0.70	0.7				
7	60.00	11	43.00	43				

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